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(71) Applicant(s)
Woon Yong Kim
154-4 Kansuk 2-dong, Namdong-gu, Inchon-City, Republic of Korea

(72) Inventor(s)
Woon Yong Kim

(74) Agent and/or Address for Service
Marks & Clerk
57-60 Lincoln's Inn Fields, LONDON, WC2A 3LS, United Kingdom

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(54) Abstract Title
Controlling a pan/tilt camera drive to centre the camera on a target

(57) The camera has separate pan and tilt motors 161, 171, each driving the camera 180 through respective gearing 162, 172. The rotary direction and angle between a target X_2, Y_2, captured in the camera screen and the camera pointing direction X_1, y_1, is calculated, and the motors are driven according to a timer interrupt signal having a regular cycle 110, and a predetermined rotating speed to move the camera to centre it on the target. Several cameras may be linked through data transceiver 130 or the camera may be linked with a host computer 30.

FIG. 1

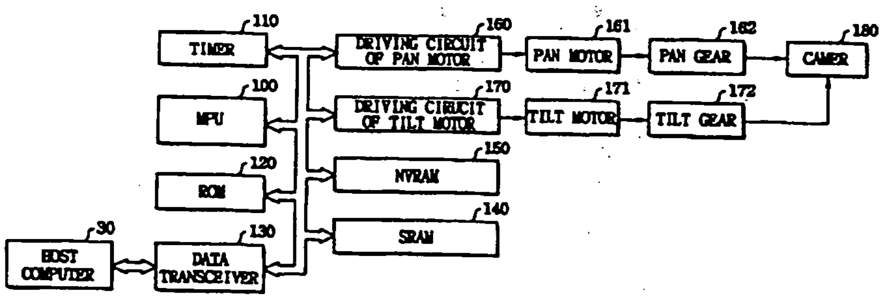

FIG. 6

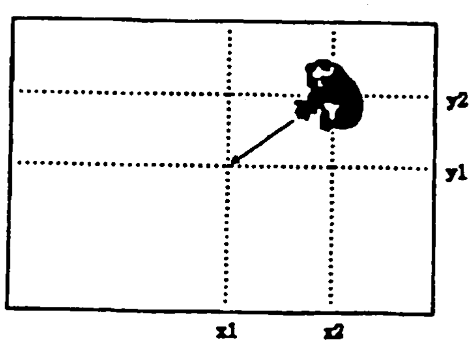

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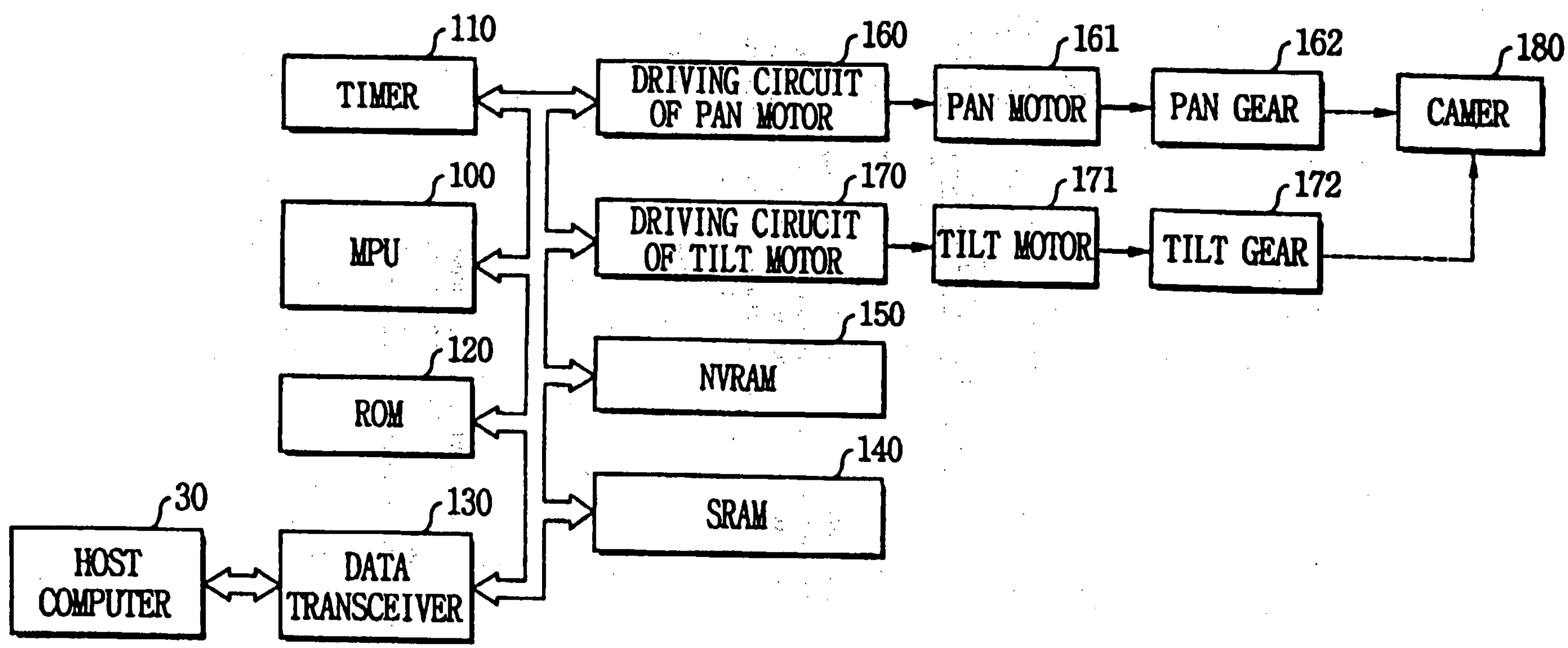
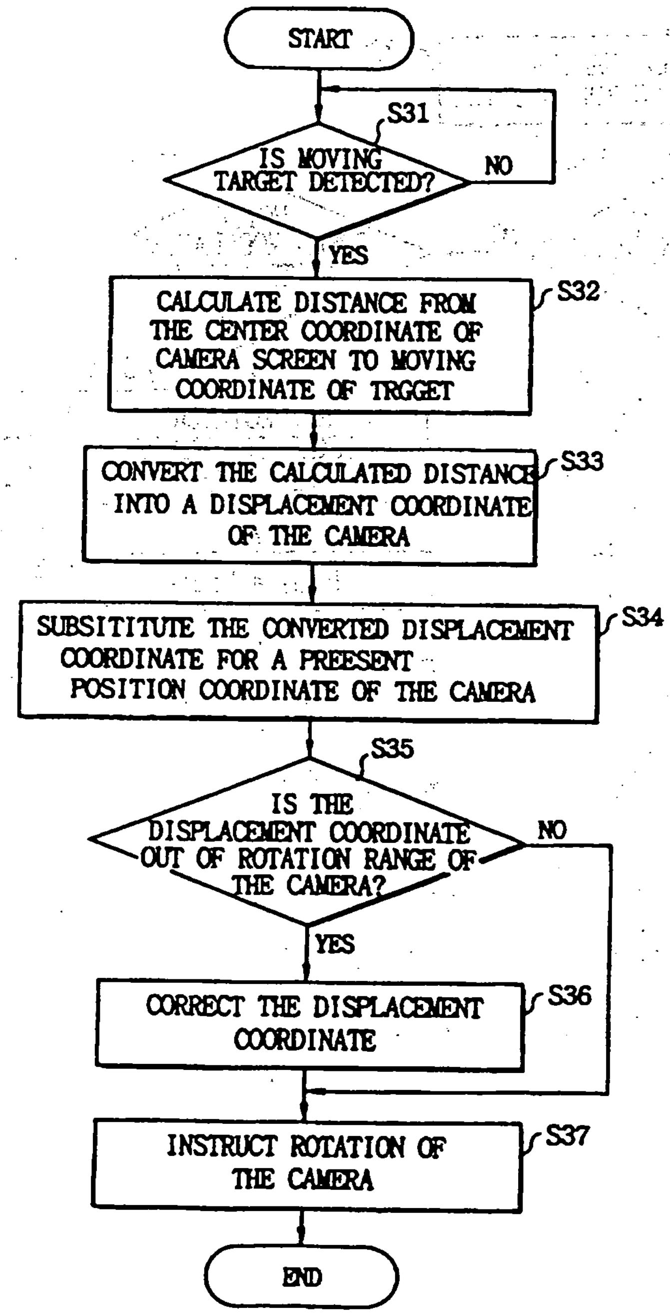
FIG. 1



TIMER
110
MPU
100
ROM
120
DATA TRANSCEIVER
130
HOST COMPUTER
30
DRIVING CIRCUIT OF PAN MOTOR
160
DRIVING CIRUCIT OF TILT MOTOR
170
NVRAM
150
SRAM
140
PAN MOTOR
161
TILT MOTOR
171
PAN GEAR
162
TILT GEAR
172
CAMER
180

FIG. 2


START
S31
IS MOVING TARGET DETECTED?
NO
YES
CALCULATE DISTANCE FROM THE CENTER COORDINATE OF CAMERA SCREEN TO MOVING COORDINATE OF TRGGET
S32
CONVERT THE CALCULATED DISTANCE INTO A DISPLACEMENT COORDINATE OF THE CAMERA
S33
SUBSITITUTE THE CONVERTED DISPLACEMENT COORDINATE FOR A PREESENT POSITION COORDINATE OF THE CAMERA
S34
S35
IS THE DISPLACEMENT COORDINATE OUT OF ROTATION RANGE OF THE CAMERA?
NO
YES
CORRECT THE DISPLACEMENT COORDINATE
S36
INSTRUCT ROTATION OF THE CAMERA
S37
END

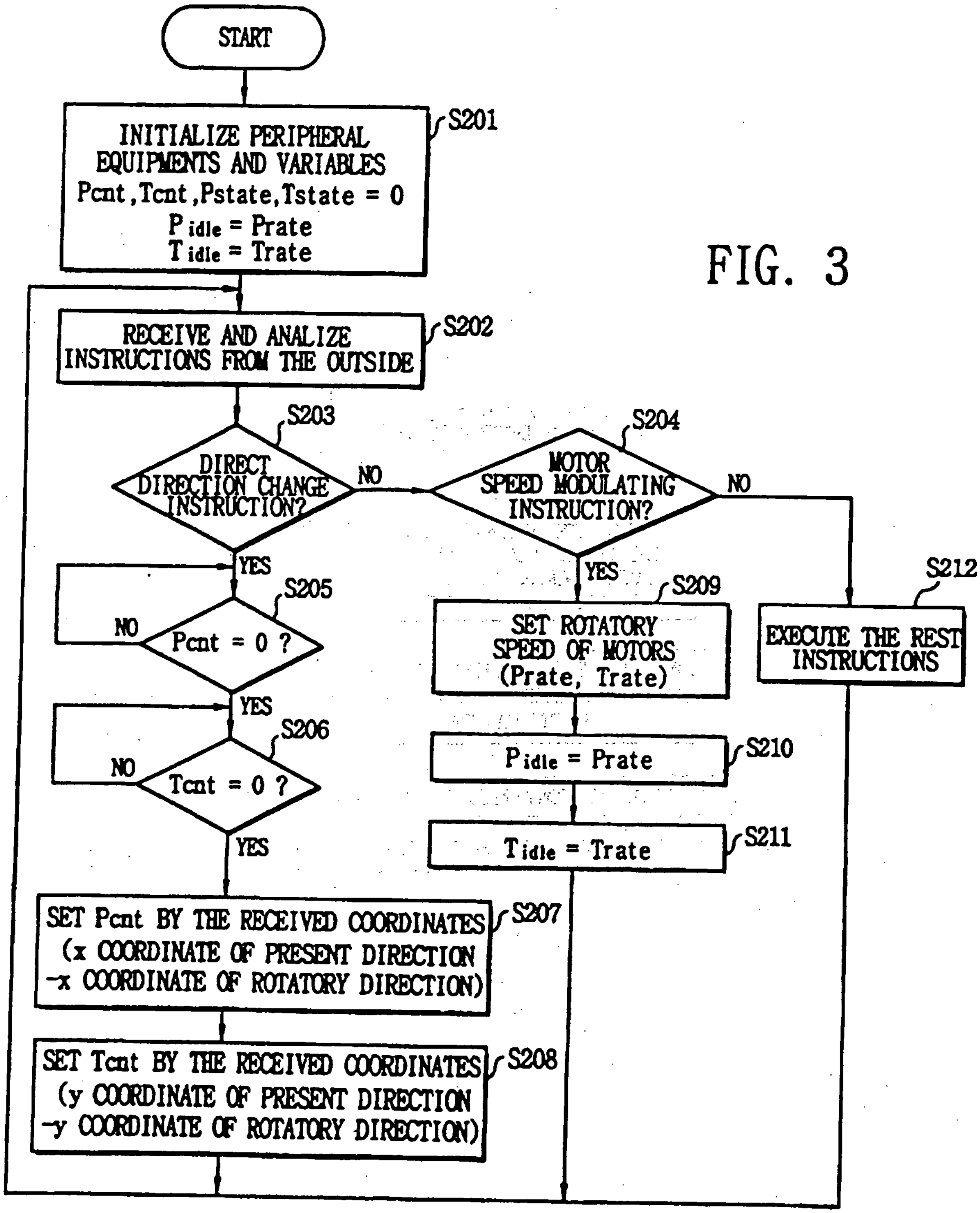

START
INITIALIZE PERIPHERAL EQUIPMENTS AND VARIABLES Pcnt,Tcnt,Pstate,Tstate = 0 Pidle = Prate Tidle = Trate
S201
RECEIVE AND ANALIZE INSTRUCTIONS FROM THE OUTSIDE
S202
DIRECT DIRECTION CHANGE INSTRUCTION?
S203
NO
MOTOR SPEED MODULATING INSTRUCTION?
S204
NO
YES
Pcnt = 0 ?
S205
NO
YES
Tcnt = 0 ?
S206
NO
YES
SET Pcnt BY THE RECEIVED COORDINATES (x COORDINATE OF PRESENT DIRECTION -x COORDINATE OF ROTATORY DIRECTION)
S207
SET Tcnt BY THE RECEIVED COORDINATES (y COORDINATE OF PRESENT DIRECTION -y COORDINATE OF ROTATORY DIRECTION)
S208
YES
SET ROTATORY SPEED OF MOTORS (Prate, Trate)
S209
Pidle = Prate
S210
Tidle = Trate
S211
EXECUTE THE REST INSTRUCTIONS
S212

FIG. 3

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FIG. 4

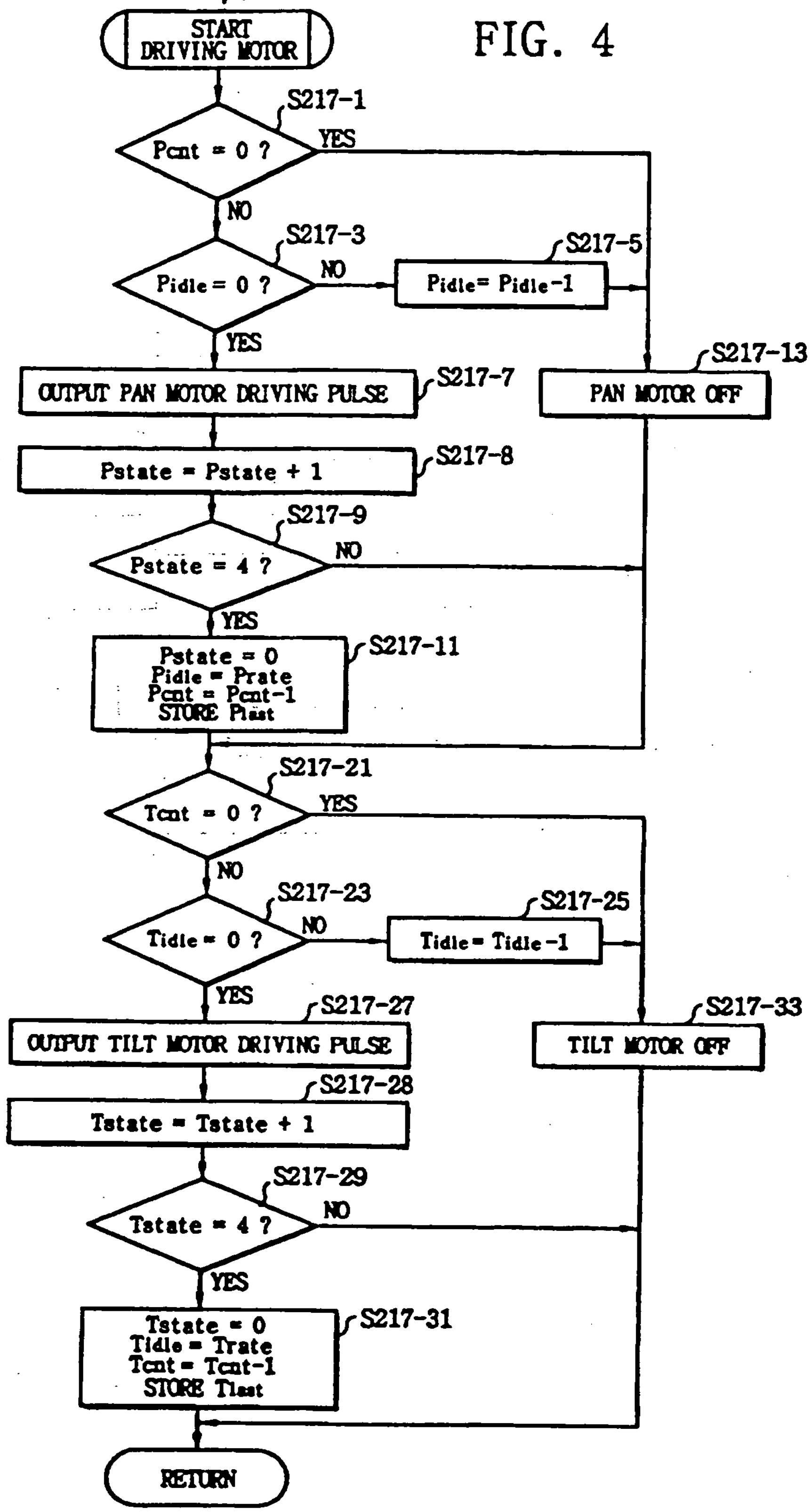

START DRIVING MOTOR
S217-1
Pcnt = 0 ?
YES
NO
S217-3
Pidle = 0 ?
NO
S217-5
Pidle= Pidle-1
YES
OUTPUT PAN MOTOR DRIVING PULSE
S217-7
S217-13
PAN MOTOR OFF
Pstate = Pstate + 1
S217-8
S217-9
Pstate = 4 ?
NO
YES
Pstate = 0
Pidle = Prate
Pcnt = Pcnt-1
STORE Plast
S217-11
S217-21
Tcnt = 0 ?
YES
NO
S217-23
Tidle = 0 ?
NO
S217-25
Tidle= Tidle-1
YES
OUTPUT TILT MOTOR DRIVING PULSE
S217-27
S217-33
TILT MOTOR OFF
Tstate = Tstate + 1
S217-28
S217-29
Tstate = 4 ?
NO
YES
Tstate = 0
Tidle = Trate
Tcnt = Tcnt-1
STORE Tlast
S217-31
RETURN

FIG. 5

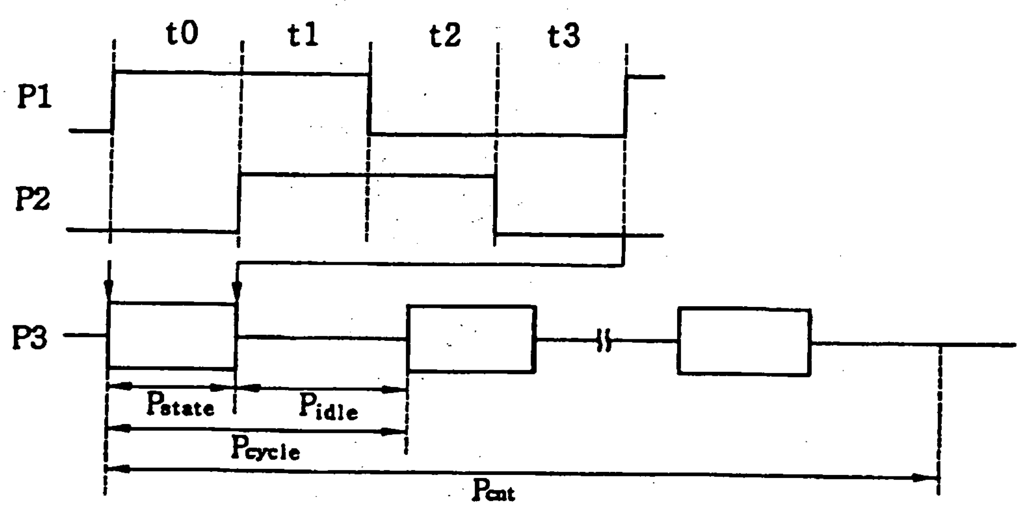


FIG. 6

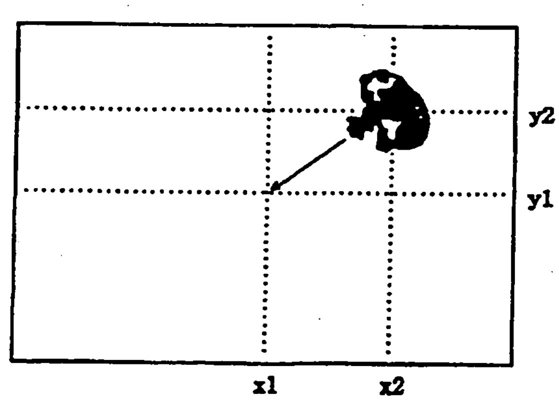


FIG. 7

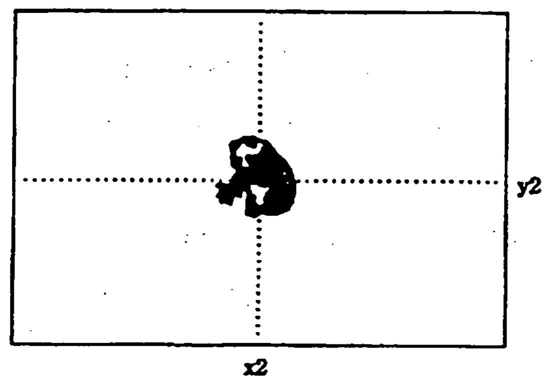
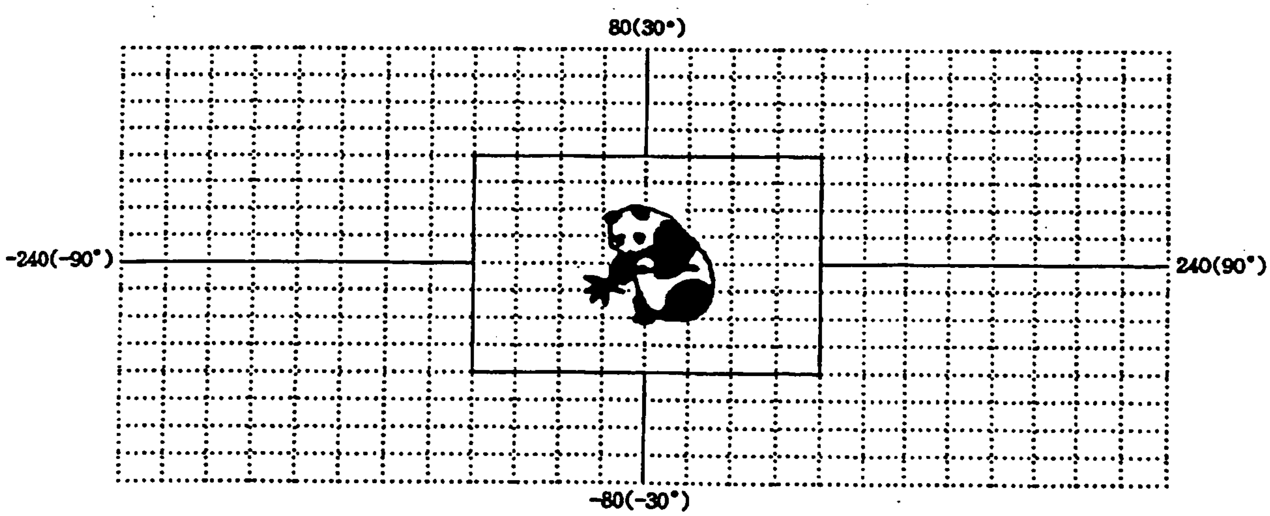


FIG. 8



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APPARATUS AND METHOD OF CONTROLLING PAN/TILT CAMERA

BACKGROUND OF THE INVENTION

1. Technical field

The present invention relates to apparatus and a method of controlling a pan/tilt camera, which may photograph a face of an object intelligently. In particular, the present invention provides apparatus and method of controlling a pan/tilt camera for dividing a camera screen virtually, recognizing a positional coordinate of an object captured in the camera screen, and rotating the camera directly to the positional coordinate of the recognized object by controlling both or either a pan driver for horizontal rotation and/or a tilt driver for vertical rotation so that the pan/tilt cameras may track and selectively photograph a face portion of the object intellectually.

2. Description of the Prior Art

A camera used to photograph an image is applied to more and more various fields such as an unmanned supervisory system, a picture telephone, etc. Therefore there are more needs for a function of rotating the camera into a desired direction.

An existing pan/tilt camera is embodied to rotate left/right or up/down by two or more motors for x-axis driving and y-axis driving independently. The controller for switching directions of the camera uses a scan and detecting method in which a user intentionally zooms and draws a target on a camera screen to the center thereof with viewing the target on a screen of a view finder. Such method employs a wire or wireless remote controller, controls the two or more motors separately, and thereby rotates the camera left/right or up/down in accordance with the target.

But the conventional pan/tilt camera controlling apparatus

controls each of the x-axis and y-axis driving motors separately with use of respective control key, resulting that the camera may not rotate smoothly. Also it takes much time to switch direction of the camera it is very difficult to capture motion of the target.

In order to control rotation of the camera automatically, respective software for controlling the x-axis driving motor and the y driving axis motor should be realized respectively. In addition, the conventional apparatus has a disadvantage that separate operation of two pieces of the software for the two motors makes processing speed slow.

SUMMARY OF THE INVENTION

Therefore, the present invention is designed to overcome the above problems of the prior art. An object of the present invention is to provide apparatus and method of controlling a pan/tilt camera, which determines where a face of an object is positioned on a screen of a camera view finder, and directly modulates direction of the camera in order to capture the face of the object on center of the screen such that the camera may rotate along motion of the face of the object in order to intelligently photograph the face.

In order to perform the object, an embodiment of the present invention provides a method of controlling a Pan/Tilt camera left/right or up/down with use of a pan motor (for x axis driving) for left/right rotation, a driving circuit for the pan motor, a tilt motor (for y axis driving) for up/down rotation and a driving circuit for the tilt motor and mechanically combined with the two motors through reduction means respectively, wherein the method of controlling the Pan/Tilt camera comprises the steps of generating a timer interrupt signal having a regular cycle when the camera captures a motion of a target, and

calculating a rotatory direction and a rotatory angle of the camera by using a central point of a camera screen and a central point of the target captured in the camera screen; and controlling the motors by driving the pan motor and the tilt motor according to the timer interrupt signal having a regular cycle and rotating the camera on the basis of a predetermined rotating speed and the calculated rotatory direction and rotatory angle.

In order to perform the object, another embodiment of the present invention provides a method of controlling Pan/Tilt cameras left/right or up/down through a data transceiver with use of a pan motor for left/right rotation, a driving circuit for the pan motor, a tilt motor for up/down rotation and a driving circuit for the tilt motor, and a plurality of the cameras mechanically combined with the two motors through reducing means and connecting each other in parallel by the data transceiver respectively, wherein the method of controlling the Pan/Tilt cameras comprises the steps of generating a timer interrupt signal having a regular cycle when the camera captures a motion of a target, and calculating a rotatory direction and a rotatory angle with use of a central point of a camera screen and a central point of the target; and controlling the motors by driving the pan motor and the tilt motor in accordance with the timer interrupt signal having a regular cycle and rotating the camera on the basis of a predetermined rotatory speed and the calculated rotatory direction and angle.

In the above embodiments, the rotatory angle calculating step may set horizontal and vertical rotation ranges by a detail rotatory angle determined by the two motors and the reduction means, and virtually subdivide the camera screen into the rotation step count corresponding to the detail rotatory angle of the camera in order to recognize the central point of the target detected in the camera screen as an objective

point of rotating the camera.

The motor controlling step may comprise the steps of initializing peripheral equipment of the motor and variables thereof; receiving and analyzing instructions from outside; setting the rotation step count (Pcnt) of the pan motor and the rotation step count (Tcnt) of the tilt motor with use of a present central point of the camera screen and the central point of the target according to present states of the pan motor and the tilt motor in order to rotate each of the cameras in case of receiving a direct direction change instruction among the received instructions; and/or modulating a rotatory speed of each camera by setting the rotatory speed of the pan and tilt motors into new values in case of receiving a motor speed modulating instruction of the motor among the received instructions.

The instruction receiving and analyzing step may comprise the steps of selectively receiving an instruction corresponding to each camera by checking a camera identification code; analyzing the received instruction; determining whether the analyzed instruction is the direct direction change instruction or not; and/or determining whether the analyzed instruction is the motor speed modulating instruction in case that the analyzed instruction is not the direct direction change instruction.

The direct direction change instruction may be performed by a direction designating function for designating the central point of the target detected by the camera as an objective point of rotating the motor.

The motor controlling step may comprise the steps of driving the pan motor forward or backward with reference to a state count value (Pstate) of a motor driving pulse and the rotatory direction (Pdir) of the pan motor with checking the rotation step count (Pcnt) and a rotation

idle value (Pidle) of the pan motor at every timer interrupt signal having a predetermined cycle; and driving the tilt motor forward or backward with reference to a state count value (Tstate) of a motor driving pulse and the rotatory direction (Tdir) of the tilt motor with checking the rotation step count (Tcnt) and a rotation idle value (Tidle) of the tilt motor at every timer interrupt signal having a predetermined cycle.

The motor controlling step may control the steps of driving the pan motor and the tilt motor independently and/or perform the steps of driving the pan motor and the tilt motor sequentially.

The pan motor driving step may comprise the steps of checking the rotation step count (Pcnt) of the pan motor and the rotation idle value (Pidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Pcycle), and thereby determining whether to drive the pan motor or not while modulating the rotatory speed of the pan motor; driving the pan motor forward or backward by outputting a series of motor driving pulses with reference to the state count value (Pstate) classified by state of the motor driving pulse and the rotatory direction (Pdir) of the pan motor; and finding out ending time of a cycle of the motor driving pulse (Pcycle) of one motor by checking the state count value (Pstate) of the motor driving pulse, and at the ending time, initializing the state count value (Pstate) and the rotation idle value (Pidle), updating the rotation step count (Pcnt) of the pan motor, and storing present position (Plast) of the pan motor.

The tilt motor driving step may comprise the steps of checking the rotation step count (Tcnt) of the tilt motor and the rotation idle value (Tidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Tcycle), and thereby determining whether to drive the tilt motor or not with modulating the rotatory speed of the tilt motor; driving the tilt motor forward or backward by outputting a series

of motor driving pulses with reference to the state count value (Tstate) classified by state of the motor driving pulse and the rotatory direction (Tdir) of the tilt motor; and finding out ending time of the cycle of driving one motor (Tcycle) by checking the state count value (Tstate) of the motor driving pulse, and at the ending time, initializing the state count value (Tstate) and the rotation idle value (Tidle), updating the rotation step count (Tcnt) of the tilt motor, and storing present position (Tlast) of the tilt motor.

In order to perform the object, an embodiment of the present invention provides an apparatus for controlling a Pan/Tilt camera left/right or up/down with use of a pan motor (for x axis driving) for left/right rotation, a driving circuit for the pan motor, a tilt motor (for y axis driving) for up/down rotation and a driving circuit for the tilt motor and mechanically combined with the two motors through reduction means respectively, wherein the apparatus for controlling the Pan/Tilt camera comprises a timer for generating an interrupt signal having a regular cycle for driving the pan motor or the tilt motor at every predetermined time; program storing means (ROM) for storing a series of motor driving programs which count the rotation step count of the motors at every interrupt signal generated by the timer and controlling the pan motor or the tilt motor sequentially in accordance with a rotatory direction and a predetermined rotatory speed of the motor; a main process unit (MPU) for storing an identification code of a camera to be controlled, calculating a rotatory direction and a rotatory angle of the camera by a specific instruction from outside with use of a central point of a camera screen and a central point of the target and operating the motor driving program stored in the ROM in accordance with the timer interrupt signal; first data storing means (SRAM) for storing data needed for the main process unit to drive the pan motor or

the tilt motor; second data storing means (NVRAM) for storing data related to present positions of the pan motor or the tilt motor after the main process unit executes the motor drive program; and a data transceiver (UART & RS232) for providing sender/receiver port and path in order that the main process unit communicates with outside.

The main process unit may store rotation ranges of the pan and tilt motors, predetermined on the basis of detail rotatory angle of the camera determined by the two motors and the reducing means, and a camera screen subdivided virtually into the rotation step count corresponding to the detail rotatory angle of the camera, and count the rotation step count in the subdivided screen when driving the motors so that the central point of the target captured in the camera screen is recognized as an objective point of rotating the camera

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings, in which like components are referred to by like reference numerals. In the drawings:

FIG. 1 is a schematic block diagram showing configuration of an apparatus for controlling a pan/tilt camera according to the present invention;

FIG. 2 is a flow chart for illustrating a signal process in case that a determining unit of a host computer generates a camera rotating instruction;

FIG. 3 is a flow chart for illustrating a signal process in a main process unit of FIG. 1 for explaining a method of controlling the pan/tilt camera according to the present invention;

FIG. 4 is a flow chart for illustrating a signal process in a motor driving subroutine;

FIG. 5 shows an example of wave shape for explaining motor driving pulses and their variables defined in the present invention; and

FIGs. 6 to 8 show examples of display for explaining an addressing concept in the camera screen subdivided with a regular interval and its direct direction change function.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 1 is a schematic block diagram for showing configuration of an apparatus for controlling a pan/tilt camera according to the present invention. Referring to the FIG. 1, the apparatus comprises a camera 180 which may rotate left/right or up/down, a pan motor 161 and a driving circuit 160 thereof for rotating the camera left/right, a tilt motor 171 and a driving circuit 170 thereof for rotating the camera up/down, and a pan gear 162 and a tilt gear 172 for mechanically combining the motors 161, 171 to the camera 180 in order to reduce rotatory speed of the motors 161, 171. In addition, the apparatus further comprises a timer 110 for generating an interrupt signal having a regular cycle for driving the pan motor or the tilt motor at every predetermined time; a ROM 120 for storing a series of motor driving programs which count a rotation step count of each motor at every interrupt signal generated by the timer and controlling the pan motor or the tilt motor sequentially in accordance with a rotatory direction and a predetermined rotatory speed of the motor; a main process unit (MPU) 100 for storing an identification code of a camera to be controlled, calculating a rotatory

direction and a rotatory angle of the camera by a specific instruction from outside with use of a central point of a camera screen and a central point of a target captured in the camera screen of the camera, and operating the motor driving program stored in the ROM in accordance with the timer interrupt signal; a static RAM (SRAM) 140 for storing data needed for the main process unit to drive the pan motor or the tilt motor; and a non-volatile RAM (NVRAM) 150 for storing the second data relevant to a camera identification code or a present data related to present position of the pan motor or the tilt motor after the main process unit executes the motor drive program. The apparatus of the present invention also comprises a data transceiver 130 such as UART or RS232 for providing sender/receiver port and path in order that the main process unit may communicate with the outside.

At this time, the main process unit MPU 100 may operate independently, and be also connected to an external host computer 30 through the data transceiver 130. Therefore, the main process unit 100 may control motion of the camera according to an instruction from the external host computer 30. In this case, the MPU should store an identification code of the camera to be controlled. In order to perform an direct direction change instruction from outside, the MPU stores data rotation ranges of the pan motor and the tilt motor, predetermined on the basis of a detail rotatory angle of the camera determined by the two motors and the reducers, and a camera screen subdivided virtually into the rotation step count corresponding to the detail rotatory angle of the camera. And the MPU counts the rotation step count in the subdivided screen when driving the motors so that the central point of the target captured in the camera screen is recognized as an objective point of rotating the camera.

The host computer 30 determines whether the coordinate of the

target changes on the screen and calculates distance between the center of the screen and a changed coordinate of the target. And the host computer 30 may comprise a direction change determining unit (not shown in the figures) for giving a camera rotating instruction to the MPU together with a camera identification code CID of a corresponding camera in order to move the camera as much as the calculated distance.

Each of the pan/tilt driving motor and the reducing unit includes a step motor and a gearbox. In particular, the step motor rotates 18°/pulse by 240pps left/right and 80pps up/down in order to correspond to the rotation step count of 240 left/right steps on the basis of x axis and 80 steps up/down on the basis of y axis, which makes the motor rotate 12 times per one second. At this time, the gearbox reduces rotation of the step motor at the rate of 1/48 and then driving torque of the camera becomes 672g·cm(max) in order that the pan/tilt camera rotates at an angular speed of 90°/sec right/left and 30°/sec up/down. And the drive torque may be modulated in accordance with change of the rotation step count on the subdivided screen.

In addition, the central point of the pan/tilt 180 camera is a reference point of driving the camera, and the pan/tilt camera turns toward the reference point when initially supplying power. Therefore the camera then rotates from the reference point to a direction of customer default or according to the intention of the user.

On the other hand, the camera identification code (CID) has an initial value of x'00' when the camera is delivered from a factory. However, the CID may be changed from x'00' to x'FF' arbitrarily according to an instruction from outside. All of the pan/tilt cameras recognize a common macro identification code (MID) and a unique

camera identification code (CID). The macro identification code (MID) is used in common regardless of the unique camera identification code (CID) and set as x'00'.

FIG. 2 exemplarily shows a signal flow of a direction change determining unit for generating a camera rotating instruction to a camera capturing the target. Referring to FIG. 2, the host computer 30 may comprise a control logic having the steps of determining whether the coordinate of the target on the screen moves S31, calculating distance from the center coordinate of the camera screen to the moving coordinate of the target and converting the distance into a displacement coordinate of the camera S32, S33, substituting the converted displacement coordinate for a present position coordinate of the camera, and checking whether the displacement coordinate is within the rotation range of the camera S34, S35, and correcting the displacement coordinate and instructing rotation of the camera in case that the displacement coordinate is not in the rotation range, or instructing rotation of the camera immediately in case that the displacement coordinate is in the rotation range S36, S37.

FIG. 3 is a flow chart for illustrating a signal process in the main process unit of the FIG. 1 in order to explain the method of controlling the pan/tilt camera according to the camera rotating instruction of FIG. 2 of the present invention. Referring to the FIG. 3, one embodiment of the method of the present invention comprises the steps of initializing peripheral equipments of the motor and their variables and waiting for receiving a direct direction change instruction and a motor speed modulating instruction with analyzing instructions given from outside S201-S204; checking whether the pan/tilt motors stop in case of receiving the direct direction change instruction, calculating the rotatory direction and angle of the camera with use of the received

present central point of the camera screen and the received central point of the target in stopping state of two motors, setting the rotation step count (Pcnt) of the pan motor and the rotation step count (Tcnt) of the tilt motor according to the calculated direction and angle, and thereby controlling the subroutine of the pan and tilt motors in accordance with the timer interrupt signal having a regular cycle S205-S208, and setting the rotatory speed of the pan and tilt motors into new value in case of receiving the motor speed modulating instruction S209-S211. In here, the step of waiting for receiving the direct direction change instruction comprises the steps of selectively receiving an instruction corresponding to each camera by checking a camera identification code CID from the outside (not shown in the flow chart), analyzing the received instruction S202; determining whether the analyzed instruction is the direct direction change instruction or not S203; and determining whether the analyzed instruction is the motor speed modulating instruction or not S204. And the direct direction change instruction can be, of course, performed by a direction designating function for designating the central point of the target detected by the camera as an objective point of rotating the motor.

The signal process in the flow chart is only one embodiment for illustrating the method of controlling a camera left/right or up/down through a data transceiver with use of a pan motor for left/right rotation, a driving circuit thereof, a tilt motor for up/down rotation and a driving circuit thereof, and a plurality of cameras mechanically combined with the two motors through reducers and connecting each other in parallel by the data transceiver,

In such signal process the method may have another embodiment only comprising a rotatory direction and angle calculating step for calculating the rotatory direction and angle of the camera with use of a

central point of the camera screen and a central point of the target captured by the camera, and a motor controlling step for driving the pan motor and the tilt motor according to the timer interrupt signal having a regular cycle and rotating the camera on the basis of a predetermined rotatory speed and the calculated rotatory direction and rotatory angle.

In the embodiments of the present invention, the rotatory angle calculating step sets horizontal and vertical rotation ranges by a detail rotatory angle determined by the two motors and the reduction units, and virtually subdivides the camera screen into the rotation step count corresponding to the detail rotatory angle of the camera in order to recognize the central point of the target detected in the camera screen as an objective point of rotating the camera.

FIG. 4 is a flow chart for illustrating a signal process in the motor controlling step. Referring to FIG. 4, the motor controlling step may comprise the steps of driving the pan motor forward or backward with reference to a state count value (Pstate) of a motor driving pulse and the rotatory direction (Pdir) of the pan motor with checking the rotation step count (Pcnt) and a rotation idle value (Pidle) of the pan motor at every timer interrupt signal having a predetermined cycle S217-1 to S217-13; and driving the tilt motor forward or backward with reference to a state count value (Tstate) of a motor driving pulse and the rotatory direction (Tdir) of the tilt motor with checking the rotation step count (Tcnt) and a rotation idle value (Tidle) of the tilt motor at every timer interrupt signal having a predetermined cycle S217-21 to S217-33.

The pan motor driving step is executed when generating the timer interrupt signal. The pan motor driving step comprises the steps of checking the rotation step count (Pcnt) of the pan motor and the rotation idle value (Pidle) determining delay time to the next driving

pulse at every cycle of the motor driving pulse (Pcycle), and thereby determining whether to drive the pan motor or not while modulating the rotatory speed of the pan motor S217-1 to S217-5 & S217-13; driving the pan motor forward or backward by outputting a series of the motor driving pulses with reference to the state count value (Pstate) classified by state of the motor driving pulse and the rotatory direction (Pdir) of the pan motor S217-7, S217-8; and finding out ending time of the cycle of driving one motor (Pcycle) by checking the state count value (Pstate) of the motor driving pulse, and at the ending time, initializing the state count value (Pstate) and the rotation idle value (Pidle), updating the rotation step count (Pcnt) of the pan motor, and storing present position (Plast) of the pan motor S217-9, S217-11.

The tilt motor driving step is executed when generating the timer interrupt signal. And, the tilt motor driving step comprises the steps of checking the rotation step count (Tcnt) of the tilt motor and the rotation idle value (Tidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Tcycle), and thereby determining whether to drive the tilt motor or not with modulating the rotatory speed of the tilt motor S217-21 to S217-25 & S217-33; driving the tilt motor forward or backward by outputting a series of the motor driving pulses with reference to the state count value (Tstate) classified by state of the motor driving pulse and the rotatory direction of the tilt motor Tdir S217-27, S217-28; and finding out ending time of the cycle of driving one motor (Tcycle) by checking the state count value (Tstate) of the motor driving pulse, and at the ending time, initializing the state count value (Tstate) and the rotation idle value (Tidle), updating the rotation step count (Tcnt) of the tilt motor, and storing present position (Tlast) of the tilt motor S217-29, S217-31.

At this time, the pan motor driving step and the tilt motor driving

step may be executed with use of separate processes. Therefore, the present invention may operate the pan motor driving step and the tilt motor driving step independently or sequentially, or even in turn.

FIG. 5 shows an example of wave shape for explaining the motor driving pulses and their variables defined in the present invention, in which shapes and terms of two pulses P1,P2 provided to each polar of the step motor and the motor driving pulse P3. In the figure, t0, t1, t2, t3 are for classifying 4 kinds of states of the drive pulses of the pan motor, while two pulse signals P1, P2 from t0 to t3 are examples in case that the motor rotates clockwise. Pcycle indicates a output cycle of a driving pulse of one pan motor and includes a variable for delaying motor driving (Pidle) and an output time of a pan motor driving pulse (Pstate) indicated as t0, t1, t2, t3. Pcnt shows a desired value of Pcycle for driving and Pcnt is designated by an exterior computer or a main control unit, which substantially controls the camera.

Although not shown in the figure, the driving pulse of the tilt motor is identical with the driving pulse of the pan motor, and not described here.

FIG. 6 and FIG. 7 show that, in case that the central coordinate of the present camera is M(x1, y1) and the central coordinate of the target captured in the camera screen is T(x2, y2) , the main process unit calculates x axis displacement (|x2-x1|) and y axis displacement (|y2-y1|) between two coordinates with use of the steps in the subdivided screen, and then moves the central point of the target (x2,y2) as much as the calculated displacement in order to locate the target at the central point of the screen (0,0).

FIG. 8 shows a subdivided maximum rotation range having a regular interval within which the camera may rotate, in which a rectangular at a central portion corresponds to display of a view finder

screen of the camera. The central point of the camera may move left/right or up/down within the maximum rotation range so to display a desired portion on the screen.

Operation and effect of the present invention as constructed above will be explained. But, the operation is explained as an example in which a plurality of the pan/tilt cameras are connected in parallel with and controlled by a host computer.

At first, a direct direction addressable feature is the most unique characteristic of the pan/tilt camera according to the present invention. Supposing that the central point of the camera is M(x1, y1). If a coordinate of the target is T(x2, y2), the direction change determining unit of the host computer detects the target on the screen, and calculates displacement from M to T through the signal process of FIG. 2. And, the host computer generates the direct direction change instruction to the MPU I order to rotate the camera to T(x2, y2). At this time, the x axis and y-axis driving units rotate the camera independently such that the camera may directly rotate on the shortest path.

For the purpose of this, the pan and tilt motors of the present invention employ the step motors, which are accurate in controlling a rotatory angle. The step motor rotates 18°/pulse by 240pps left/right and 80pps up/down in order to correspond to the rotation step count, which makes the motor rotate 12 times per one second. And, the reducing unit includes the gearbox, which reduces rotation of the step motor at the rate of 1/48 and then the drive torque of the camera becomes 672g·cm(max). Therefore, the pan/tilt camera rotates at an angular speed of 90°/sec right/left and 30°/sec up/down. In particular, the pan motor may rotate the camera in a rotation range of ±90° right/left through the reducing unit by rotating 240 steps

right/left at 0.375°/step. On the while, the tilt motor may rotate the camera in a range of ±30° up/down through the reducing unit by rotating 80 steps up/down at 0.375°/step.

In order to designate the rotatory direction of the camera clearly, the horizontal and vertical rotation ranges of the camera are designated in advance with the detail angle determined by the step motors and the reducing gears. And the camera screen is virtually subdivided with the rotation step count corresponding to the detail rotatory angle of the camera such that the central point of the target detected in the camera screen may be recognized as an objective coordinate of rotating the camera.

As shown in FIG. 3, the signal process for controlling the pan/tilt is executed according to the direct direction change instruction among the various instructions from the exterior computer to the main process unit 100 through an RS-232 serial communication. In addition, the signal process for controlling the pan/tilt motors starts in accordance with the timer interrupt signal generated periodically from the timer 110 by the MPU 100 providing several variables to the timer.

At first, the MPU 100 initializes the variables required to drive the motors s201, selectively receives an appropriate instruction corresponding to each motor by checking the camera identification code (CID) from the outside S202, analyzes the received instruction S202, and then determines whether the received instruction is the direct direction change instruction S203. At this time, the direct direction change instruction is made by a direction designating function, which designates the coordinate of the center of the target as an objective point of rotating the motor. As the result of the determination, if the MPU receives the direct direction change instruction from outside, the MPU calculates the rotatory directions (Pdir, Tdir) and the rotating

angles of the cameras with use of the present central point of the camera screen and the present central point of the target, and then sets the rotation step count (Pcnt, Tcnt) S207, S208.

In case of detecting the target as shown in FIG. 6, the MPU 100 calculates the rotation step count (Pcnt, Tcnt) in manner of x1-x2=Pcnt and y1-y2=Tcnt, and then transmits the Pcnt and Tcnt as the timer interrupt signal. At this time, a calculated symbol +/- is transmitted to the timer interrupt signal as a directional symbol of the camera in Pdir and Tdir.

As explained above, the timer interrupt signal starts driving the motors at the time of setting Pdir, Pcnt, Tdir and Tcnt. At this time, rotatory speed of the motor is determined according to Prate, which is established to the Pan/Tilt camera as a separate instruction.

And the timer performs a signal process for driving the motors in accordance with the timer interrupt signal having a regular cycle in order to drive the pan motor or the tilt motor sequentially and rotate the camera until the central point of the target locates on the central point of the screen. At this time, the rotatory speed of each motor is determined on the basis of the predetermined rotatory speed (Prate, Trate).

The motor driving signal processing step receives a variable for designating the rotatory direction of the pan motor (Pdir), a variable for designating the rotatory angle of the step motor (Pcnt) and a variable for modulating the rotatory speed of the camera (Prate) from the exterior apparatus so to rotate the pan motor to a desired direction.

As shown in FIG. 4, the step of S217-1 determines whether to drive the pan motor by checking the rotation step count (Pcnt). In case that the rotation step count (Pcnt) is "0", the MPU recognizes that there is no need to drive the motor anymore and then stops the driving. In

case that the rotation step count (Pcnt) is not "0", the MPU drives the motor until the Pcnt comes to "0". At this time, update of the Pcnt is executed at the step of S217-11, where the motor driving pulse output cycle ends.

Then the steps of S217-3 and S217-5 modulates the rotatory speed (Prate) of the pan motor by counting the rotation idle value (Pidle) of the pan motor at every Pcycle.

Then, the step of S217-7 outputs a series of pulse signals to the pan motor with reference to the state count value (Pstate) classified with t0, t1, t2, t3 and the rotatory direction (Pdir) of the pan motor. The motor is driven forward or backward in accordance with the pulse signal.

Then, the step of S217-9 updates the state count value (Pstate) used in S217-7 and maintains the state count value (Pstate) in range between t0 and t3. Therefore, Pstate changes in such a manner of t0-t1-t2-t3-t0-t1-t2-···at every interrupt signal.

The step of S217-11 initializes Pstate into t0 at the ending time of Pcycle, which is an output cycle of the motor driving pulse, and initializes Pidle by duplicating Prate to Pidle. And then, the step S217-11 updates Pcnt in accordance with end of the one driving cycle, and then storing Plast, a present position of the motor, in the non-volatile RAM.

In here, the function of Pidle is counting every timer interrupts, adjusting the cycle of driving the motor, and thereby modulating the rotatory speed of the motor.

The steps of driving the tilt motor S217-21 to S217-33 are identical to the steps of driving the pan motor, and may be connected to a front or back of the flow chart of driving the pan motor.

The present invention may track a target captured by the camera

rapidly by subdividing the camera screen virtually to have a regular interval, detecting the position of the target in the subdivided camera screen, and thereby rotating the camera directly toward the target, which gives advantages of making tracking of the target and software process using the image recognition simple, enhancing process speed, and increasing rotating speed of the camera.

The apparatus and control method of controlling the pan/tilt camera according to the present invention have been described in detail. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

CLAIMS:

1. A method of controlling a Pan/Tilt camera left/right or up/down with use of a pan motor (for x axis driving) for left/right rotation, a driving circuit for the pan motor, a tilt motor (for y axis driving) for up/down rotation and a driving circuit for the tilt motor and mechanically combined with the two motors through reduction means respectively, wherein the method of controlling the Pan/Tilt camera comprises the steps of:

generating a timer interrupt signal having a regular cycle when the camera captures a motion of a target, and calculating a rotatory direction and a rotatory angle of the camera by using a central point of a camera screen and a central point of the target captured in the camera screen; and

controlling the motors by driving the pan motor and the tilt motor according to the timer interrupt signal having a regular cycle and rotating the camera on the basis of a predetermined rotating speed and the calculated rotatory direction and rotatory angle.

2. The method of controlling the Pan/Tilt camera as claimed in claim 1, wherein the rotatory angle calculating step sets horizontal and vertical rotation ranges by a detail rotatory angle determined by the two motors and the reduction means, and virtually subdivides the camera screen into the rotation step count corresponding to the detail rotatory angle of the camera in order to recognize the central point of the target detected in the camera screen as an objective point of the rotating the camera.

3. The method of controlling the Pan/Tilt camera as claimed

in claim 1, wherein the motor controlling step comprises the steps of:

driving the pan motor forward or backward with reference to a state count value (Pstate) of a motor driving pulse and the rotatory direction (Pdir) of the pan motor with checking the rotation step count (Pcnt) and a rotation idle value (Pidle) of the pan motor at every timer interrupt signal having a predetermined cycle; and

driving the tilt motor forward or backward with reference to a state count value (Tstate) of a motor driving pulse and the rotatory direction (Tdir) of the tilt motor with checking the rotation step count (Tcnt) and a rotation idle value (Tidle) of the tilt motor at every timer interrupt signal having a predetermined cycle.

4. The method of controlling the Pan/Tilt camera as claimed in claim 3, wherein the motor controlling step controls the steps of driving the pan motor and the tilt motor independently.

5. The method of controlling the Pan/Tilt camera as claimed in claim 3, wherein the motor controlling step performs the steps of driving the pan motor and the tilt motor sequentially.

6. The method of controlling the Pan/Tilt camera as claimed in claim 3, wherein the pan motor driving step comprises the steps of:

checking the rotation step count (Pcnt) of the pan motor and the rotation idle value (Pidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Pcycle), and thereby determining whether to drive the pan motor or not while modulating the rotatory speed of the pan motor;

driving the pan motor forward or backward by outputting a series of motor driving pulses with reference to the state count value (Pstate)

classified by state of the motor driving pulse and the rotatory direction (Pdir) of the pan motor; and

finding out ending time of a cycle of the motor driving pulse (Pcycle) of one motor by checking the state count value (Pstate) of the motor driving pulse, and at the ending time, initializing the state count value (Pstate) and the rotation idle value (Pidle), updating the rotation step count (Pcnt) of the pan motor, and storing present position (Plast) of the pan motor.

7. The method of controlling the Pan/Tilt camera as claimed in claim 3, wherein the tilt motor driving step comprises the steps of:

checking the rotation step count (Tcnt) of the tilt motor and the rotation idle value (Tidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Tcycle), and thereby determining whether to drive the tilt motor or not with modulating the rotatory speed of the tilt motor;

driving the tilt motor forward or backward by outputting a series of motor driving pulses with reference to the state count value (Tstate) classified by state of the motor driving pulse and the rotatory direction (Tdir) of the tilt motor; and

finding out ending time of a cycle of the motor driving pulse (Tcycle) of one motor by checking the state count value (Tstate) of the motor driving pulse, and at the ending time, initializing the state count value (Tstate) and the rotation idle value (Tidle), updating the rotation step count (Tcnt) of the tilt motor, and storing present position (Tlast) of the tilt motor.

8. A method of controlling Pan/Tilt cameras left/right or up/down through a data transceiver with use of a pan motor for

left/right rotation, a driving circuit for the pan motor, a tilt motor for up/down rotation and a driving circuit for the tilt motor, and a plurality of the cameras mechanically combined with the two motors through reducing means and connecting each other in parallel by the data transceiver respectively, wherein the method of controlling the Pan/Tilt cameras comprises the steps of:

generating a timer interrupt signal having a regular cycle when the camera captures a motion of a target, and calculating a rotatory direction and a rotatory angle with use of a central point of a camera screen and a central point of the target; and

controlling the motors by driving the pan motor and the tilt motor in accordance with the timer interrupt signal having a regular cycle and rotating the camera on the basis of a predetermined rotatory speed and the calculated rotatory direction and angle.

9. The method of controlling the Pan/Tilt camera as claimed in claim 8, wherein the rotatory angle calculating step sets horizontal and vertical rotation ranges by a detail rotatory angle determined by the two motors and the reduction means, and virtually subdivides the camera screen into the rotation step count corresponding to the detail rotatory angle of the camera in order to recognize the central point of the target detected in the camera screen as an objective point of rotating the camera.

10. The method of controlling the Pan/Tilt camera as claimed in claim 8, wherein the motor controlling step comprises the steps of:

initializing peripheral equipment of the motor and variables thereof;

receiving and analyzing instructions from outside; and

setting the rotation step count (Pcnt) of the pan motor and the rotation step count (Tcnt) of the tilt motor with use of a present central point of the camera screen and the central point of the target according to present states of the pan motor and the tilt motor in order to rotate each of the cameras in case of receiving a direct direction change instruction among the received instructions.

11. The method of controlling the Pan/Tilt camera as claimed in claim 9, wherein the motor controlling step further comprises the step of modulating a rotatory speed of each camera by setting the rotatory speed of the pan and tilt motors into new values in case of receiving a motor speed modulating instruction of the motor among the received instructions.

12. The method of controlling the Pan/Tilt camera as claimed in claim 10, wherein the instruction receiving and analyzing step comprises the steps of:

selectively receiving an instruction corresponding to each camera by checking a camera identification code;

analyzing the received instruction;

determining whether the analyzed instruction is the direct direction change instruction or not; and

determining whether the analyzed instruction is the motor speed modulating instruction in case that the analyzed instruction is not the direct direction change instruction.

13. The method of controlling the Pan/Tilt camera as claimed in claim 10, wherein the direct direction change instruction is performed by a direction designating function for designating the

central point of the target detected by the camera as an objective point of rotating the motor.

14. The method of controlling the Pan/Tilt camera as claimed in claim 10, wherein the motor controlling step comprises the steps of:

driving the pan motor forward or backward with reference to a state count value (Pstate) of a motor driving pulse and the rotatory direction (Pdir) of the pan motor with checking the rotation step count (Pcnt) and a rotation idle value (Pidle) of the pan motor at every timer interrupt signal having a predetermined cycle; and

driving the tilt motor forward or backward with reference to a state count value (Tstate) of a motor driving pulse and the rotatory direction (Tdir) of the tilt motor with checking the rotation step count (Tcnt) and a rotation idle value (Tidle) of the tilt motor at every timer interrupt signal having a predetermined cycle.

15. The method of controlling the Pan/Tilt camera as claimed in claim 10, wherein the motor controlling step controls the steps of driving the pan motor and the tilt motor independently.

16. The method of controlling the Pan/Tilt camera as claimed in claim 14, wherein the motor controlling step performs the steps of driving the pan motor and the tilt motor sequentially.

17. The method of controlling the Pan/Tilt camera as claimed in claim 14, wherein the pan motor driving step comprises the steps of:

checking the rotation step count (Pcnt) of the pan motor and the rotation idle value (Pidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Pcycle), and thereby

determining whether to drive the pan motor or not while modulating the rotatory speed of the pan motor;

driving the pan motor forward or backward by outputting a series of motor driving pulses with reference to the state count value (Pstate) classified by state of the motor driving pulse and the rotatory direction (Pdir) of the pan motor; and

finding out ending time of a cycle of the motor driving pulse (Pcycle) of one motor by checking the state count value (Pstate) of the motor driving pulse, and at the ending time, initializing the state count value (Pstate) and the rotation idle value (Pidle), updating the rotation step count (Pcnt) of the pan motor, and storing present position (Plast) of the pan motor.

18. The method of controlling the Pan/Tilt camera as claimed in claim 10, wherein the tilt motor driving step comprises the steps of:

checking the rotation step count (Tcnt) of the tilt motor and the rotation idle value (Tidle) determining delay time to the next driving pulse at every cycle of the motor driving pulse (Tcycle), and thereby determining whether to drive the tilt motor or not with modulating the rotatory speed of the tilt motor;

driving the tilt motor forward or backward by outputting a series of motor driving pulses with reference to the state count value (Tstate) classified by state of the motor driving pulse and the rotatory direction (Tdir) of the tilt motor; and

finding out ending time of the cycle of driving one motor (Tcycle) by checking the state count value (Tstate) of the motor driving pulse, and at the ending time, initializing the state count value (Tstate) and the rotation idle value (Tidle), updating the rotation step count (Tcnt) of the tilt motor, and storing present position (Tlast) of the tilt motor.

19. An apparatus for controlling a Pan/Tilt camera left/right or up/down with use of a pan motor (for x axis driving) for left/right rotation, a driving circuit for the pan motor, a tilt motor (for y axis driving) for up/down rotation and a driving circuit for the tilt motor and mechanically combined with the two motors through reduction means respectively, wherein the apparatus for controlling the Pan/Tilt camera comprises:

a timer for generating an interrupt signal having a regular cycle for driving the pan motor or the tilt motor at every predetermined time;

program storing means (ROM) for storing a series of motor driving programs which count the rotation step count of the motors at every interrupt signal generated by the timer and controlling the pan motor or the tilt motor sequentially in accordance with a rotatory direction and a predetermined rotatory speed of the motor;

a main process unit (MPU) for storing an identification code of a camera to be controlled, calculating a rotatory direction and a rotatory angle of the camera by a specific instruction from outside with use of a central point of a camera screen and a central point of the target and operating the motor driving program stored in the ROM in accordance with the timer interrupt signal;

first data storing means (SRAM) for storing data needed for the main process unit to drive the pan motor or the tilt motor;

second data storing means (NVRAM) for storing data related to present positions of the pan motor or the tilt motor after the main process unit executes the motor drive program; and

a data transceiver (UART & RS232) for providing sender/receiver port and path in order that the main process unit communicates with outside.

20. The apparatus for controlling the Pan/Tilt camera as claimed in claim 19, wherein the main process unit stores rotation ranges of the pan and tilt motors, predetermined on the basis of detail rotatory angle of the camera determined by the two motors and the reducing means, and a camera screen subdivided virtually into the rotation step count corresponding to the detail rotatory angle of the camera, and counts the rotation step count in the subdivided screen when driving the motors so that the central point of the target captured in the camera screen is recognized as an objective point of rotating the camera.

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Claims searched: 1-20

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G3N NGCA4A, NGE3B, NGE3BA.

Int Cl (Ed.7): F16M 11/12, 11/18; G05D 3/18; G08B 13/196, 15/00; H04N 5/232

Other: ONLINE: EPODOC, JAPIO, WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2,289,144 A	(BRIARS) - note pulse width modulation supply to motors on page 8 paragraph 2.	1 at least.
X	EP 0,690,616 A	(MATSUSHITA ELECTRIC INDUSTRIAL CO.) - note equally spaced pulses at intervals T_3 and T_{13} in figures 6 and 8.	1 at least.
X	EP 0,525,482 A	(SENSORMATIC ELECTRONICS CORPORATION) - note pulse width modulation supply to motors eg on page 8 lines 40-56.	1 at least.
X	US 5,802,412	(KAHN) - see column 6, particularly interrupts eg on column 6 line 19.	1 at least.
X	US 5,561,518	(PARKERVISION INC.) - see column 10 lines 11-24.	1 at least.

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